Exxon Valdez Oil Spill

Restoration Project Final Report

Survival of Adult Murres and Kittiwakes in Relation to Forage Fish Abundance

Restoration Project 00338

Final Report

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Finall Report

Study History: This project was first funded in 1998 after reviewers recommended that the APEX project (Restoration Project 00163) obtain data on adult seabird survival in order to better understand population-level effects of variability in food abundance. We used traditional methods of banding and re-sighting to measure the survival of adult Common Murres and Black-legged Kittiwakes at two colonies in lower Cook Inlet. A pilot banding effort in 1997 was followed by further banding in 1998, 1999, and 2000 and by exhaustive efforts to re-sight banded birds in 1998, 1999, 2000 and 2001. This effort complemented other studies in lower Cook Inlet that related seabird breeding success and foraging effort to fluctuations in forage fish density.

Abstract: We measured adult seabird survival by marking birds with color bands and re-sighting them in subsequent years. With 5 years of effort (including 4 years of banding followed each by 4 years of re-sighting), we are able to generate 3 three years of over-winter survival estimates for Common Murres and Black-legged Kittiwakes at Gull and Chisik islands in lower Cook Inlet (note that for seabirds, which commonly skip breeding in consecutive years, survival probability estimates for the last year of a study cannot be decoupled from re-sighting probabilities, and so are unreliable). We used two techniques to estimate survival: enumeration to calculate survival and mark-recapture analysis (using Program MARK) to calculate both survival and re-sighting probabilities. Results suggest there are marked differences in survival of murres and kittiwakes between Gull and Chisik islands, which are related to costs of breeding in food-rich versus food-poor environments. Findings are consistent with life history strategies of the two species, and results of the larger APEX study (Project 00163M) of seabird biology in lower Cook Inlet.

<u>Key Words</u>: Cook Inlet, murre, kittiwake, survival, forage fish, *Exxon Valdez* oil spill, Kachemak Bay, population, demography, life history, parental investment.

<u>Project Data</u>: *Description of data* – individual birds were captured in the field, measured and sampled for blood, and tagged with color and metal bands. *Format* – All data associated with this study are included as part of this report in Appendix 1. Digital data in the form of an Excel spreadsheet may be obtained upon request from John Piatt, Alaska Science Center, USGS, 1011 E. Tudor Rd., Anchorage AK 99503.

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<u>Executive Summary</u>: Populations of Common Murres and Black-legged Kittiwakes in lower Cook Inlet fluctuate over time, and changes in population size reflect the sum of three processes: adult mortality, recruitment of locally-produced offspring, and the immigration/emigration of breeding adults from/to other colonies. In APEX Project 00163M, we measured population trends and productivity in relation to local food abundance during 1995-1999, and there are also historical data spanning 25 years. With this project (00338), we measured adult survival by marking birds with color bands and re-sighting them in subsequent years. We now have estimates of over-winter survival for murres and kittiwakes at Gull Island (food-rich, bird populations increasing) and Chisik Island (food-poor, bird populations decreasing) for three annual cycles (from 1997 to 1998, 1998 to 1999, and 1999 to 2000). Results suggest there are differences in survival of murres and kittiwakes between Gull and Chisik islands, which may be related to costs of breeding in food-rich versus food-poor environments. Annual survival of adult kittiwakes on Chisik (0.97, 0.92, 0.91, respectively) was significantly and consistently higher than on Gull (0.82, 0.85, 0.89, respectively), presumably because of the much higher reproductive investment by kittiwakes on Gull, which rear and fledge many offspring. In contrast, Chisik kittiwakes chronically fail to hatch many chicks from eggs, and rarely raise or fledge viable offspring. Murres at both colonies fledged young every year

and had similar long-term reproductive success. In contrast to kittiwakes, murres at the food-rich colony (Gull) had marginally (but consistently) higher annual survival (1.0, 0.88,0.94, respectively) than murres at the food-deprived colony (Chisik, 0.93, 0.86, 0.93, respectively). Survival of adult murres was positively correlated with body condition at the end of the breeding season, the rate at which adults could provision chicks, and early breeding phenology; but not with food supply, breeding success or stress hormone levels. Survival of adult kittiwakes was negatively correlated with food supply, breeding success, and the rate at which adults could provision chicks; but not with breeding phenology, body condition, or stress hormone levels. These findings are consistent with life history strategies of the two species, and results of the larger APEX study (Project 00163M) of seabird biology in lower Cook Inlet. The rate at which murre and kittiwake populations are declining at Chisik Island (4-9% per annum) can be attributed mostly to adult mortality. If there is any recruitment at Chisik, it must be offset by emigration. The rate at which populations have increased at Gull Island (9%) cannot be explained solely by recruitment of locally produced juveniles (despite high productivity), and must also result from substantial immigration of adults from elsewhere.

Introduction: Some seabird populations in the Gulf of Alaska have undergone marked fluctuations during the past few decades (Hatch and Piatt 1995; Piatt and Anderson 1996), including periods of decline or non-recovery. Ultimately, the ability of injured or declining seabird populations to recover depends on: 1) breeding success, or productivity; 2) fledgling survival and subsequent recruitment; and 3) overwinter survival of adults (Harris and Wanless 1988). Without concurrent measurement of at least two of these three parameters, it is difficult to determine which factor is limiting population recovery.

Mechanisms that regulate seabird populations are poorly understood, but food supply is clearly important (Cairns 1992). Studies sponsored by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) in 1995-99 (APEX, Restoration Project 00163) have shown linkages between food supply and population dynamics. APEX focused on forage fish availability and its relationship with seabird productivity and foraging effort. The link between food supply during the breeding season and adult survival remains unclear, but mounting evidence suggests that overwinter survival is linked to reproductive investment (Golet et al. 1998), which may in turn be partially a function of food supply during the breeding season (Kitaysky et al. 1999).

Therefore, we set out to determine the overwinter survival of adult Common Murres (*Uria aalge*) and Black-legged Kittiwakes (*Rissa tridactyla*) by using traditional banding and re-sighting methods at Gull and Chisik islands in lower Cook Inlet. Results of past work show clear differences in prey availability between the two colonies, with forage fish being scarce around Chisik Island and abundant around Gull Island (Robards et al. 1999, 2002; Abookire and Piatt 2004). Seabirds must work significantly harder at Chisik to provide food to their chicks (Zador and Piatt 1999, Piatt 2002). This difference is manifested in markedly reduced kittiwake productivity at Chisik Island, and higher physiological stress (Kitaysky et al. 1999). Because kittiwake populations have been steadily declining at Chisik, but increasing at Gull, one might be tempted to conclude that low recruitment in combination with low adult survival are responsible for the decline in kittiwake populations at Chisik.

In contrast, murres exhibit similar levels of productivity at Chisik and Gull, but the Chisik Island murre population has historically declined at an even greater rate than the kittiwake population (Piatt 2002). Thus, the murre population decline at Chisik Island and concurrent increase at Gull Island must be attributable to differences among islands in rates of adult murre survival and/or recruitment/immigration.

In any case, we assumed that the measurement of survival rates, in conjunction concurrent studies on food supply, foraging effort and colony productivity (Piatt 2002) would help to resolve the mechanisms underlying seabird population fluctuations, particularly for those species such as murres that are able to buffer productivity against periods of food shortage by increasing foraging effort (Burger and Piatt 1990; Zador and Piatt 1999). Presumably, such effort comes at a cost—perhaps in reduced adult survival.

Objectives:

1. To determine adult Common Murre and Black-legged Kittiwake overwinter survival rates, using conventional banding and re-sighting methods.

2. To relate differences in Common Murre and Black-legged Kittiwake overwinter survival to differences in prey availability, foraging effort and physiological stress during the breeding season.

3. To relate differences in Common Murre and Black-legged Kittiwake overwinter survival to differences in breeding success (reproductive investment).

Methods: To measure annual survival of kittiwakes and murres, we employed traditional mark-recapture methods. Adult breeding birds were captured and marked using a uniquely numbered stainless steel leg band and a unique combination of colored plastic leg bands. Marked birds were then observed at the colony in subsequent years to determine "recapture" rates. Those recapture rates can then be translated into estimated survival rates by simple enumeration (Golet et al. 1998, 2001) or by using established statistical models (Pollock et al. 1990, Lebreton et al. 1992). In enumeration, one calculates survival simply as the proportion of birds marked in year that are alive in year two. Enumeration requires that resighting effort be adequate to assume that all birds that can be observed are, in fact, observed. In other words, resighting probability is assumed to be 100 percent. Although this assumption is not unreasonable at small seabird colonies, it is complicated by the fact that adult birds may skip breeding for a year or more, and thus are neither resighted nor dead. This issue is less a problem when you have multiple years of data.

Live recaptures are the basis of the standard Cormack-Jolly-Seber model. Program MARK (White and Burnham 1999) provides parameter estimates from marked animals when they are re-encountered at a later time. As for enumeration, re-sighting must take place over at least 4-5 years to accurately measure survival with recapture models (Lebreton et al. 1992). Re-sighting probabilities vary with observer effort and can also be lowered when birds occasionally skip breeding attempts, a common event for kittiwakes and other seabirds (Erikstad et al. 1995, Golet et al. 1998). Thus, several years of effort are recommended in order to ensure a high probability of re-sighting individuals that have, in fact, survived since banding but may be missed if re-sighting effort is limited to only one or two subsequent years.

The basic input to program MARK is the encounter history for each animal. Parameters can be constrained to be the same across re-encounter occasions, or by sex, or by group (e.g., colony), using the parameter index matrix (PIM). A set of common models for screening data initially are provided, with time effects, group effects, time*group effects, and a null model of none of the above provided for each parameter. Program MARK computes the estimates of model parameters via numerical maximum likelihood techniques. The program that does this computation also determines numerically the number of parameters that are estimable in the model, which is used to compute the quasi-likelihood AIC value (QAICc) for the model. The approach generally taken with MARK is to find a model that provides the best fit for the data, as indicated by the lowest possible AICc value.

Assuming a binomial distribution (sample unit being an individual adult, with survival being a yes or no), we calculated in a power analysis prior to our study that a sample size of 47 marked birds per island would resolve a 6% difference in survival between colonies with acceptable statistical power and confidence. To double the resolution (3%) would have required a sample size about five times greater. Previous studies reported murre survival rates ranging from 87% to 98% (Hudson 1985, Sydeman 1993) and kittiwake survival rates ranging from 82% to 93% (Golet et al. 1998). Given that our study colonies represent relative extremes of population growth and decline, it was not unreasonable to expect their survival rates to also be at the extreme ends of the normal range. Therefore, we assumed that the ability to detect a 4% difference with statistical significance would be adequate to address our primary hypothesis, and calculated that we would need to mark about 200 birds of each species at each colony.

The methods for capture and banding were straightforward. Breeding adults were captured using a telescoping fiberglass pole fitted with a noose. All captures were carried out under the authority of permits issued by the US Fish and Wildlife Service and the Alaska Department of Fish and Game. Handling times were minimized wherever possible to reduce the stress of capture. All birds captured and used for this analysis (n=1212) were actively attending a nest-site, egg, or chick. Captured birds were banded with a unique combination of color bands and a metal USFWS band. A small blood sample was taken from many birds (n=629) for measures of stress hormone and for determination (n=611) of sex (see Kitaysky et al. 1999 for details). Blood was collected and stored in a 1.8 ml vial that had been pre-filled with a buffering solution. On all birds, body mass (± 5 g) was measured using spring scales; head-plus-bill and tarsus length ± 1 mm using vernier calipers; and flattened standard wing length ± 1 mm (carpus to distal end of longest primary feather) using a stopped ruler. We scaled mass to body size as an index of body condition, dividing mass by wing length. We attempted to capture adults on a regular schedule to represent condition throughout the breeding season.

Re-sighting effort lasted for about 6 weeks in each year in which it occurred, starting before egg-laying for each species (because it quickly became difficult to re-sight bands on birds once they began incubating eggs). Birds were banded in specific areas of each colony, and notes and sketches were used to aid in relocation of birds in subsequent years. Re-sighting was carried out almost daily for weeks, as a dedicated activity and in association with other work, until re-sighting curves reached a plateau, indicating that all banded birds had been encountered (Hatch et al. 1993). Data sheets were prepared in advance of field work, containing information on previously banded birds (color band sequences, metal band numbers, locations) and to record re-sighting information. A bird was not considered a confirmed re-sight unless it had been observed at least twice, and better yet, three or more times. At the Chisik – Duck island complex, kittiwakes were banded mostly on Duck (as were all murres), but 81 of 213 kittiwakes were banded at one location on the south end of Chisik Island. This required dedicated trips from the camp on Duck Island in order to re-sight birds on Chisik. There was no significant difference in survival of kittiwakes from Chisik and Duck islands, and so these data are combined here for analyses (and generally referred to by the name of the larger island refuge: Chisik).

For both enumeration and mark-recapture methods, we used 1078 records out of 1212 birds with a complete re-sight history. Most of the 132 un-used records were from birds banded in 2001, and a few were from 1996. Other records that we eliminated included birds that were part of an experimental study to test efficiency of internally (subcutaneous and abdominal) mounted radios in murres.

Results: Total banding effort is shown in Table 1. We undertook our first serious banding effort in 1997. Owing to the small size of these two colonies, and limited habitat available for capturing birds, we were only able to capture and band relatively small numbers of birds without causing undue disturbance to other nesting seabirds. After receiving FY98 EVOSTC funding for the 1998 field season, we initiated re-sighting (a much more time-consuming activity than banding) and renewed our banding effort. Unfortunately our 1998 banding effort was undermined by effects of the 97/98 El Niño event (Piatt et al. 1999). Colony attendance at both Gull and Chisik Islands was reduced, and birds that did attend were exceptionally skittish and difficult to capture. Abnormal behavior was particularly evident at Chisik Island, where only a small percentage of the usual murre breeding sites were occupied. The few birds that did attempt to breed eventually abandoned the colony, resulting in a rare breeding failure (Piatt 2002). With renewed efforts in 1999 and 2000, we met our objective of banding a minimum of 200 birds per species per colony.

Kittiwake Survival

Analysis of data using enumeration and MARK suggests that survival of kittiwakes is much higher on Chisik than on Gull island (Table 2). While survival rates varied among years at both colonies, they were consistently higher at Chisik, although values appeared to converge over time (Fig. 1). Like Golet et al. (2001), we found that enumeration and MARK survival estimates are similar, except that MARK tends to slightly overestimate survival because it underestimates resighting probabilities, thereby inflating survival estimates (Golet et al. 2001). However, these differences were small and consistent among years. We found that about 28% of kittiwakes skip at least one year of breeding, 3% skip at least two years and 1% skip at least 3 years. The best fitting MARK model (ΔAICc=0.00; weight=0.265) was one in which survival was unequal among colonies and years, and re-sighting probabilities were unequal across years (but not colonies). This model provided a 265 times better fit (ÎAICc=11.11; weight=0.001) to the data than the otherwise equivalent model in which we assume that there was no difference in kittiwake survival among colonies. A likelihood ratio test suggests this difference in fit of models (colony effect vs. no colony effect) is highly significant (χ^2 =19.25, df=4, p<0.0007). Including body condition as a covariate of survival parameters in the best model did not improve the model (ÎAICc=1.98; weight=0.0986). Using a subset (slightly more than half) of the database, with birds in which baseline levels of corticosteroids (CORT) were measured (Kitaysky et al. 1999), the best model (ÎAICc=0.00; weight=0.244) was still one in which survival differed between colonies and years, while resighting probability differed among years (not colonies). Addition of CORT as a covariate did not improve this model, providing only about half as good a fit (ÎAICc =1.35; weight=0.124) as the best model. However, if year effects are dropped out of this model, then addition of CORT (ÎAICc=0.67; weight=0.175) to the best model provides almost (75%) as good a fit as the best model itself. In other words, year and CORT have similar effects on the fit of the model, although both are weak in comparison to colony effects.

Murre Survival

Similar analyses were conducted for murres (Table 2). MARK results are complicated by the fact that re-sighting rates were exceptionally low (0.59) in 1998 at Chisik Island owing to effects of the ENSO on murre attendance (Piatt et al. 1999). With these re-sighting rates, and because it does not account for skipped years in estimating resighting probability (Golet et al. 2001), MARK estimates of adult survival are consistently inflated (by as much as 5% at Chisik in1998). Enumeration analysis shows that 32% of murres skipped at least one year of breeding, 6% skipped two years, and <1% skipped three years. Given that enumeration methods show that only 93% of all Chisik murres banded in 1997 have ever been resighted (in 1998-2001), the MARK estimate of 99% survival is obviously a biased estimate. Therefore, we believe that the most accurate estimates of survival can be obtained from the enumeration method, although both methods give consistent results with respect to relative differences between colonies and years (Table 2). Survival from 1998 to 1999 appeared to plummet at both islands, but recovered again by 2000 (Fig. 1, Table 2).

There was a consistent (although converging) difference in survival of murres among years and overall between Gull (94.0%) and Chisik (90.8%).

The best fitting MARK model (Î AICc=0.00; weight=0.465) was one in which survival was unequal among years, body condition was a covariate with survival, and re-sighting probabilities were unequal across years and colonies. This model provided about a 2-fold better fit to the data than the otherwise equivalent model (Î AICc=1.14; weight=0.262) in which we removed body condition as a covariate. Despite an overall difference of 2.4% in murre survival between colonies, MARK did not detect a significant colony effect in a reduced model designed to test that hypothesis (χ^2 =1.804, df=1, p=0.179). Similarly, logistic regression of the binary enumeration data revealed no significant difference (χ^2 =0.36, df=2, p=0.84) in overall survival among colonies, despite an overall difference of 3.2% in survival rates between them (Table 2). However, annual differences in survival were significant for 1998 (7.0%, χ^2 =6.96, df=1, p<0.05), and marginally significant for 1999 (2.2%, χ^2 =3.65, df=1, p=0.056). In any case, we predicted from statistical power tests that it would be difficult to distinguish a 3% or less difference with the target sample sizes. Because the difference between Gull and Chisik murre survival is close to this threshold, and because we observed the same trends at each island (survival always higher at Gull, and changes similar at both colonies among years), we believe the difference is biologically meaningful.

Using a subset (slightly more than half) of the database, with birds in which baseline levels of corticosteroids (CORT) were measured (Kitaysky et al. 1999), the best model (Î AICc=0.00; weight=0.295) was still one in which survival was unequal between years, while resighting probability was unequal among years and colonies. Addition of CORT as a covariate did not improve this model (Î AICc=2.05; weight=0.106), providing only about one-third as good a fit as the best model.

Effects of breeding and environment

We collected data on the environment and biology of murres and kittiwakes at the same time and place as this survival study. Details of these studies can be found in Piatt (2002) and associated

APEX publications (e.g., Zador and Piatt 1998, Kitaysky et al. 1999, Robards et al. 1999, 2002; Harding et al. 2003, Piatt et al. 1999, Abookire and Piatt 2004). Because we have data for each species on two colonies in three years, we are able to assess simple correlations between survival and relevant biological parameters with a sample size of n=6 in most cases (failure of kittiwakes to rear chicks at Chisik reduced our sample size to n=4 in some cases, see Table 3). Biological parameters were reduced to mean annual values for this analysis (e.g., average chick feeding rate over all days of examined, or, average body condition of adults captured during late chick-rearing).

We already knew that murre breeding success was insensitive to the wide range of prey densities that we observed in the APEX study (Piatt 2002), and so it was not surprising to find that survival of adult murres was similarly insensitive to food supply and breeding success (Table 3). Murres are more sensitive to changes in the timing of availability of food (Shultz et al., *submitted*), and we observed a marginal negative correlation between survival and median hatch dates, i.e., lower survival with later breeding. Of behavioral parameters, survival was correlated only with chick provisioning rates, i.e., low survival when chick-feeding rates were low. And finally, adult survival was strongly *and positively* correlated with adult body condition during late chick rearing— a time we know is most stressful for murres (Kitaysky, unpubl. data). The fact that body condition was a parameter in the best-fit model of survival (above), and in this analysis of correlation among annual parameter averages suggests the overall importance of adult body condition in the survival of murres. As in the MARK analysis, corticosteroid concentrations explained little of the variation in adult survival.

We already knew that, in contrast to murres, breeding success of kittiwakes is strongly correlated with prey abundance (Piatt 2002). Therefore, we were not surprised to find that kittiwake survival was correlated with annual measures of fish biomass, fledging success and overall breeding success (Table 3). The surprise is that all the correlations are negative, i.e., when fish are abundant and kittwakes are highly productive, adult birds exhibit lower survival rates. Of the remaining parameters, only rates of chick provisioning and attendance of adults at the nest were correlated with survival, i.e., when chicks were well fed and adults had surplus time to spend together at nest-sites, then adult survival was low. This is consistent with the above observations about survival and food supply, but again, is counter-intuitive.

<u>Discussion and Conclusions</u>:

These differences between Gull and Chisik islands in the survival of murres and kittiwakes probably result from differential costs of breeding in food-rich versus food-poor environments. For example, kittiwakes at Chisik Island almost always failed prior to egg hatching (producing on average of only 0.02 chicks/pair), and most birds at Chisik invested little in reproduction after incubation. Annual adult survival is quite high (93%) and similar to that observed in other failing colonies in Alaska (Fig. 2). In contrast, kittiwakes at Gull are highly productive (averaging 0.46 chicks/pair over 15 years of study), but this investment apparently takes a toll on breeding adults because survival is only about 85% per annum (similar to productive Atlantic colonies). This is a remarkable difference between colonies. Based on these survival estimates, we can calculate that the median life-span for Gull Island kittiwakes is only 5 years, compared to 14 years at Chisik. On the other hand, Gull Island kittiwakes are likely to produce 1-2 offspring during those short 5 years, while Chisik kittiwakes are likely to produce none.

The situation for murres is quite different. Murres maintain high productivity at *both* Gull (0.54 chicks/pair) and Chisik (0.56 chicks/pair) islands (Table 4), but birds at Chisik must work harder to maintain this level of productivity (e.g., >50% longer foraging trips, much less loafing time, Piatt 2002). This extra effort has some apparent cost, since adult murre survival at Chisik (91%) is lower than at Gull (94%). These survival rates are similar to those observed elsewhere (Fig. 3), with lower values found at declining colonies (e.g., Karlso) and higher values found at increasing colonies (e.g., Isle of May). Thus, in the case of murres— and in contrast to kittiwakes— the effects of food supply on survival are more intuitive. Where food is more abundant (Gull), and with equal reproductive effort, survival is slightly higher than where food is less abundant (Chisik). Further, we observed several significant correlations between survival and important parameters that reflect the ability of murres to feed their chicks (provisioning rate) and themselves (body condition). Surely this difference in survival among colonies, averaging about 3%, is biologically significant. For example, it would mean that the median age of mortality for murres on Chisik was 7 years, compared to 11 years on Gull Island. For a species that requires 4-5 years to reach sexual maturity (Hudson 1985), this is not a trivial difference.

With independent measures of survival rates, productivity and population trends (Table 4), we can also draw some conclusions about recruitment and immigration. The rate of survival of juveniles to breeding age is generally much lower than annual adult survival, and for both Common Murres (Hudson 1985, Harris and Wanless 1988) and Black-legged Kittiwakes (Baird 1994) is likely to be no more than about 40% (Table 4). The rates at which murre and kittiwake populations are declining at Chisik Island (4-9% per annum) can be explained almost entirely by adult mortality. Even with optimistic rates of juvenile survival (above), however, and assuming that all fledglings return to their natal colonies to breed, the observed population trends suggest that some immigration/emigration also occurs at Chisik (Table 4). The rates at which populations have increased at Gull Island (8-9%) cannot be explained solely by recruitment of juveniles from Gull, and must therefore also result from substantial immigration rates (2-12% p.a.) of adults from elsewhere.

In summary, we may conclude that:

1) The population dynamics of murres and kittiwakes in the EVOS spill zone are strongly influenced by food supplies that are available during the breeding season. Food supply not only affects productivity (as demonstrated by core APEX investigations reported in Piatt, 2002), but also adult survival (measured) and recruitment (inferred). This conclusion supports the hypothesis that long-term changes in forage fish abundance in the Gulf of Alaska (Anderson and Piatt 1999) could have a profound influence on the ability of seabirds to recover from losses incurred during the *Exxon Valdez* oil spill.

2) Adult survival of murres and kittiwakes differs markedly between food-rich and food-poor colonies. Differences in survival may result from inter-colony differences in parental investment required to successfully rear and fledge chicks (Golet et al. 1998). The cost of raising kittiwake chicks on Gull Island— which is only possible because of rich food supplies— takes a serious toll on adult survival. Fledging murre chicks at Chisik requires a sustained higher level of foraging effort and results in higher levels of physiological stress (Zador and Piatt 1999, Kitaysky et al. 1999). This apparently reduces overwinter survival in murres.

3) The rate of declines in populations (>90%) of murres and kittiwakes at Chisik Island during the past 25 years can be accounted for largely by adult mortality. There appears to be little recruitment or immigration. The rate of increase in populations (>90%) of murres and kittiwakes at Gull Island during the past 25 years cannot be explained solely by recruitment of locally-produced offspring, and must also result from immigration.

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Table 1. Number of birds color-banded by year, location, and species. Numbers in parentheses are those used for analyses of adult survival in this report.

Year	Gull Island		Chisik Island	
	Murre	Kittiwake	Murre	Kittiwake
1996		8		
1997	56 (27)	66	131 (129)	70
1998	103	107	54 (52)	71
1999	67	62	74	29
2000	59	60 (59)	68 (67)	36
2001	35 (0)	27 (0)	22 (0)	7 (0)
Total	**320 (256)**	**330 (294)**	**349 (322)**	**213 (206)**

Total banded: 1212 (Gull 650; Chisik 562)
Total used in analyses: 1078 (Gull 550; Chisik 528)

Table 2. Estimates of annual survival (phi) and re-sighting probabilities (p) for murres and kittiwakes in lower Cook Inlet using mark-recapture (MARK) and enumeration (ENUM) methods.

Species	Parameter	Gull Is.		Chisik Is.	
		phi	p	phi	p
Kittiwake	MARK Survival 1997 to 1998	0.826	0.912	0.987	0.789
	MARK Survival 1998 to 1999	0.874	0.749	0.934	0.837
	MARK Survival 1999 to 2000	0.904	0.942	0.932	0.916
	MARK Survival Avg 3 Years	**0.868**		**0.951**	
	ENUM Survival 1997 to1998	0.818		0.971	
	ENUM Survival 1998 to 1999	0.854		0.921	
	ENUM Survival 1999 to 2000	0.893		0.906	
	ENUM Survival Avg 3 Years	**0.855**		**0.933**	
Murre	MARK Survival 1997 to 1998	1.000	0.888	0.987	0.590
	MARK Survival 1998 to 1999	0.894	0.815	0.871	0.764
	MARK Survival 1999 to 2000	0.977	0.836	0.942	0.957
	MARK Survival Avg 3 Years	**0.957**		**0.933**	
	ENUM Survival 1997 to1998	1.000		0.930	
	ENUM Survival 1998 to 1999	0.881		0.859	
	ENUM Survival 1999 to 2000	0.938		0.934	
	ENUM Survival Avg 3 Years	**0.940**		**0.908**	

Table 3. Correlation between survival of adult seabirds and other biological parameters measured at the same time and place (data from Piatt 2002). Owing to low sample sizes for measures of annual survival, all correlations with even marginal significance ($p<0.10$) are highlighted below.

Species	Parameter	Correlation			
		n	sign	r^2	prob.
Murre	Fish biomass [1]	6	pos	0.10	0.54
	Fledging success	6	pos	0.20	0.38
	Breeding success	6	pos	0.10	0.53
	Timing of breeding [2]	**6**	**neg**	**0.52**	**0.10**
	Adult co-attendance [3]	6	pos	0.05	0.67
	Chick provisioning [4]	**6**	**pos**	**0.72**	**0.03**
	Foraging trip duration	6	neg	0.06	0.63
	Adult body condition [5]	**6**	**pos**	**0.90**	**0.01**
	Corticosteroid levels [6]	6	pos	0.17	0.42
Kittiwake	**Fish biomass [1]**	**6**	**neg**	**0.74**	**0.03**
	Fledging success	**6**	**neg**	**0.61**	**0.06**
	Breeding succcess	**6**	**neg**	**0.57**	**0.08**
	Timing of breeding [2]	6	neg	0.02	0.78
	Adult co-attendance [3]	**4**	**neg**	**0.85**	**0.08**
	Chick provisioning [4]	**4**	**neg**	**0.93**	**0.04**
	Foraging trip duration	4	neg	0.02	0.87
	Adult body condition [5]	6	pos	0.01	0.87
	Corticosteroid levels [6]	6	pos	0.37	0.20

1) Fish biomass measured with hydroacoustics, 2) based on phenology of egg hatching, 3)minutes of co-attendance by both adults at nest site, 4) mean no. of fish delivered per hour for murres, and total kJ of prey delivered per day for kittiwakes, 5) adult body condition (mass/wing length) during late chick rearing period, 6) corticosteroid concentration in blood plasma during chick rearing.

Table 4. Estimate of population parameters for seabirds at Chisik and Gull Islands.

Type	Parameter	Black-legged Kittiwake		Common Murre	
		Chisik	Gull	Chisik	Gull
Measured	Population change (prop. per annum)	-0.043	0.088	-0.089	0.091
Measured	Annual adult survival (p.p.a.)	0.933	0.855	0.908	0.940
Measured	Mean productivity (chicks/pair)	0.016	0.482	0.560	0.540
Literature	Juvenile survival to breeding	0.400	0.400	0.400	0.400
Estimated	Maximum recruitment (p.p.a.)	0.003	0.096	0.112	0.108
Estimated	Maximum (im/e)migration (p.p.a.)	0.021	0.137	-0.109	0.043

Note: recruitment and immigration must balance. For example, if no murre chicks at Chisik survived to breed, then recruitment would be zero, and emmigration would have to be 0.000 to account for population trends (ie., in this case, population decline would be equal to adult mortality).

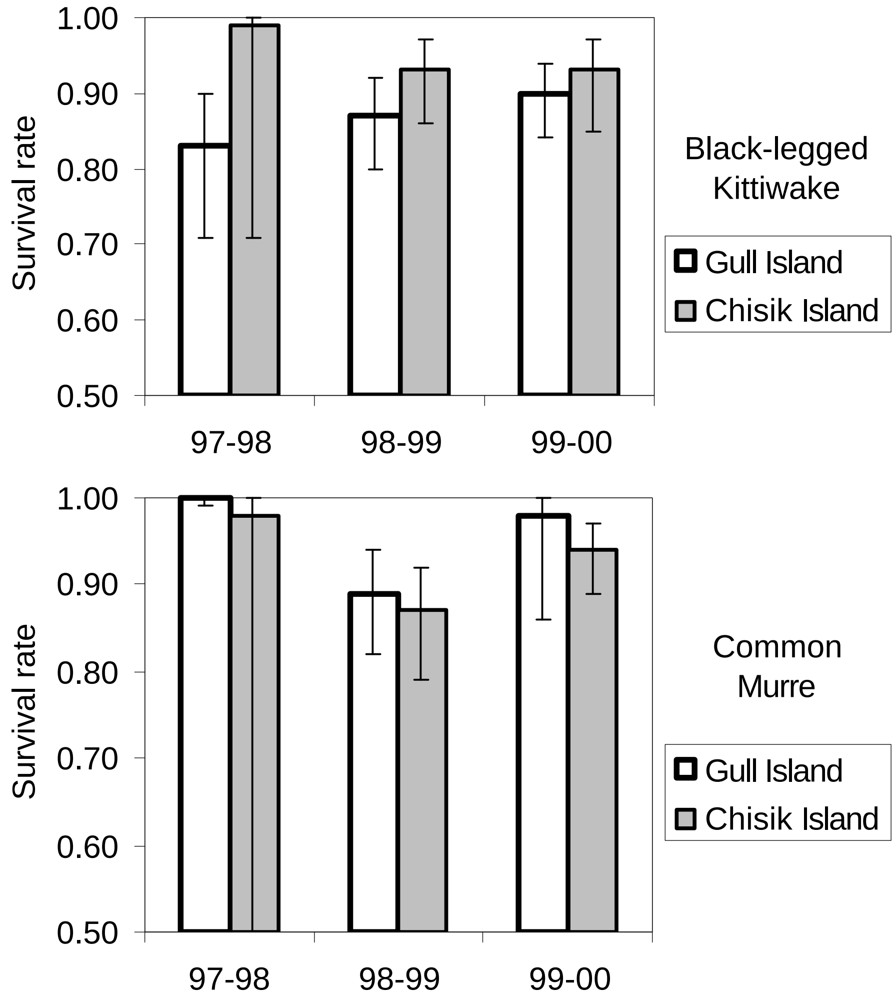

Figure 1. Annual estimates of survival (with upper and lower 95% confidence limits) generated by MARK for Black-legged Kittiwakes and Common Murres on Gull and Chisik islands, lower Cook Inlet, Alaska.

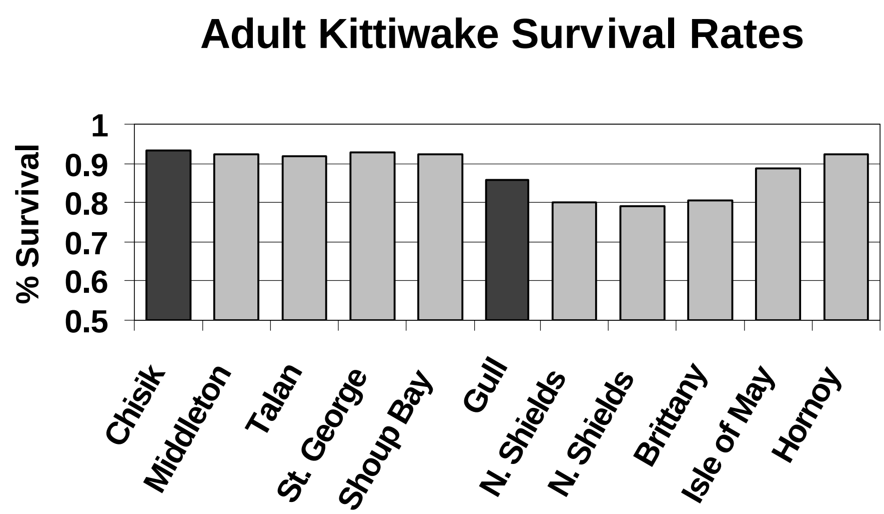

Figure 2. Estimate of Black-legged Kittiwake survival rates at Chisik and Gull islands, compared with rates of survival at other colonies in the Atlantic and Pacific oceans.

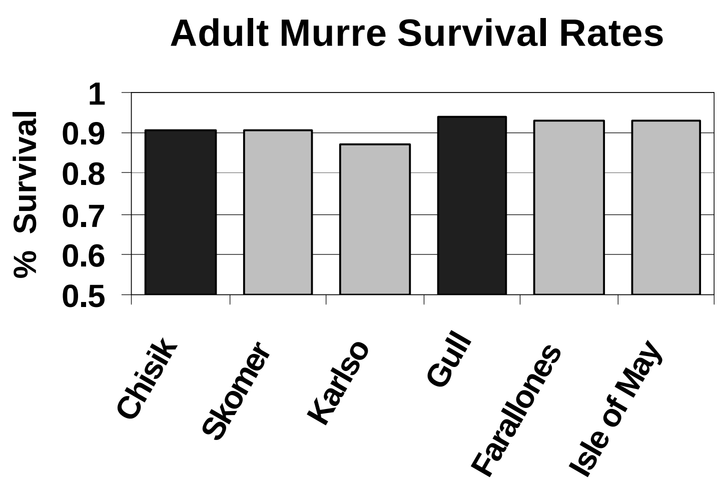

Figure 3. Estimate of Common Murre survival rates at Chisik and Gull islands, compared with rates of survival at other colonies in the Atlantic and Pacific oceans.

Appendix 1. Raw data used for estimating survival of murres and kittiwakes in lower Cook Inlet

Definition of Field Labels

Year	year of capture
Colony	colony where bird was captured
Cap Date	date of year bird was captured
Species	species captured
SK Code	Sasha Kitaysky blood code prefix; one number for year, one letter for colony, and two letters for species, e.g. "7GCM" for COMU captured Gull Island in 1997
sk#	Sasha Kitaysky blood code suffix; this is the number of the blood sample that corresponds to the blood code prefix
Adult/Chick	whether the captured bird was an adult, chick, or fledgling, ("A, C, F")
Brood Status	whether the chick was an alpha, beta, or singleton
Fate	the fate of the chick; "F" = fledged, "D" = died, "U" = unknown
L-Top	color of band on top of left leg; "B" = blue, "O" = orange, "R" = red, "G" = green, "E" = grey, "W" = white, "Y" = yellow
L-AVISE#	metal band number
R-Top	color of band on top of right leg; "B" = blue, "O" = orange, "R" = red, "G" = green, "E" = grey, "W" = white, "Y" = yellow
R-Mddl	color of band in middle of right leg; "B" = blue, "O" = orange, "R" = red, "G" = green, "E" = grey, "W" = white, "Y" = yellow
R-Bttm	color of band on botton of right leg; "B" = blue, "O" = orange, "R" = red, "G" = green, "E" = grey, "W" = white, "Y" = yellow
Recap?	Will contain "Y" if this bird captured anytime previously
Culmen	length in mm.
Depth	length in mm.
Width	length in mm.
Cut. Edge	length in mm.
Headbill	length in mm.
Wing	flattened wing length
Tarsus	diagonal length of tarsometatarsus bone along the outside edge
TAR	parallel length of tarsometatarsus bone along the outside edge
Mass (g)	weight of bird
Wet Mass	weight of bird that was very wet when captured; this was primarily used for COMU fledgers that were caught from the water
10th Primary	length in mm.
Capture Location	the location on the colony where bird was captured
Treatment	any experimental treatments or manipulations performed on bird, other than banding and measuring (See treatment code definitions below)
Freq	radio transmitter frequency
Age	age, in days, of captured bird (if known)
Chick Age	age of the adult's chick when adult was captured
Capt Time	time of day bird was captured
B-1	time blood sample one was taken
B-2	time blood sample two was taken
B-3	time blood sample three was taken
B-4	time blood sample four was taken
B-5	time blood sample five was taken
B-6	time blood sample six was taken
CORT1	levels of corticosterone in corresponding blood sample
CORT2	levels of corticosterone in corresponding blood sample
CORT3	levels of corticosterone in corresponding blood sample
CORT4	levels of corticosterone in corresponding blood sample
CORT5	levels of corticosterone in corresponding blood sample
CORT6	levels of corticosterone in corresponding blood sample

Nest Contents	contents of bird's nest at the time of capture
Obs 96	was this bird observed in 1996? "0" = no, "1" = yes
Obs 97	was this bird observed in 1997? "0" = no, "1" = yes
Obs 98	was this bird observed in 1998? "0" = no, "1" = yes
Obs 99	was this bird observed in 1999? "0" = no, "1" = yes
Obs 00	was this bird observed in 2000? "0" = no, "1" = yes
Obs 01	was this bird observed in 2001? "0" = no, "1" = yes
Caphist	the resighting history of this bird (combination of the above four fields)
Sex	sex of bird captured
Regurg	number of corresponding regurgitation
Regurg Wt.	weight of regurgitation
Notes	notes/comments

Treatment	Definition
*Codes	*these codes can be used in combination with each other
N	bird received no treatments other than morphological measurements and/or banding
B	one blood sample taken, after 3 minutes has elapsed
BB	baseline blood sample
S	stress series
H	hormone implant experiment; received sham
EH	hormone implant experiment; received hormone
ET	external radio transmitter
CH	parent of chick who was part of hormone implant experiment; chick received sham
CEH	parent of chick who was part of hormone implant experiment; chick received hormone
ITC	internal radio transmitter experiment; received surgery, but no radio
ITQX	internal radio transmitter; subcutaneous with external antennae
ITAX	internal radio transmitter; abdominal with external antennae
ITAI	internal radio transmitter; abdominal with internal antennae
ITQI	internal radio transmitter; subcutaneous with internal antennae
K	bird collected
F	refers to HOPU chicks that were part of supplementary feeding study; these were the supplementary fed chicks
UF	refers to HOPU chicks that were part of supplementary feeding study; these were the unfed control chicks
G	refers to chicks that were repeatedly measured to ascertain growth rates

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	Year	Colony	Cap Date	Species	Culmen	Headbill	Wing	Tarsus	Mass (g)	Treatment	CORT1	Nest Contents	Obs 96	Obs 97	Obs 98	Obs 99	Obs 00	Obs 01	Caphist	Sex
2	1996	Gull	30-Jul-96	BLKI									1	0	1	1	1	1	101111	
3	1996	Gull	30-Jul-96	BLKI									1	0	1	1	1	1	101111	
4	1996	Gull	4-Aug-96	BLKI	41.7	96.6	315	35	393	S		C	1	0	0	0	0	0	100000	M
5	1996	Gull	4-Aug-96	BLKI	40.3	96	320	34.77	388	S		C	1	0	1	0	0	0	101000	M
6	1996	Gull	4-Aug-96	BLKI	41.7	99.4	330	36.5	370	S		C								M
7	1996	Gull	4-Aug-96	BLKI	41	95.7	310	33.4	333	S		C	1	0	1	1	1	1	101111	F
8	1996	Gull	4-Aug-96	BLKI	40.5	95	310	35.3	330	S		C	1	0	0	0	0	0	100000	F
9	1996	Gull	8-Aug-96	BLKI	39.6	96.5	325	35	420	S		C	1	0	1	0	0	0	101000	F
10	1996	Gull		BLKI									1	0	1	0	1	1	101011	
11	1997	Duck	11-Jun-97	BLKI	38.5		315	35.5	460	S	5.38	E								
12	1997	Duck	11-Jun-97	BLKI	37.4		313	34.2	450	S	2.37	E								
13	1997	Duck	11-Jun-97	BLKI	44.3		330	36.8	435	S	4.68	E								
14	1997	Duck	11-Jun-97	BLKI	35		325	36.5	425	S	5.84	E								
15	1997	Duck	11-Jun-97	BLKI	39.3		315	34.2	420	S	3.73	E								
16	1997	Duck	11-Jun-97	BLKI	37.9		310	36.5	410	S	3.97	E								
17	1997	Duck	11-Jun-97	BLKI	37		310	33	360	S	5.35	E								
18	1997	Gull	15-Jun-97	BLKI	37.1		320	36.2	420	S	4.47	E								M
19	1997	Gull	15-Jun-97	BLKI	38.1		325	36.2	410	S	4.89	2E								F
20	1997	Gull	15-Jun-97	BLKI	37.1		315	35.5	370	S	3.38	0								F
21	1997	Gull	15-Jun-97	BLKI	37.8		320	35.4	305	S	2.16	E								F
22	1997	Gull	16-Jun-97	BLKI	40.1		329		440	S	3.23	E	0	1	1	0	0	0	011000	M
23	1997	Gull	16-Jun-97	BLKI	37.3		310	35.7	430	S	6.82	0	0	1	1	1	1	1	011111	
24	1997	Gull	16-Jun-97	BLKI	41.5		325	37.1	420	S	4.81	E	0	1	1	0	0	0	011000	M
25	1997	Gull	16-Jun-97	BLKI	39.4		315	35.8	400	S	3.7	2E	0	1	0	0	1	1	010011	
26	1997	Gull	16-Jun-97	BLKI	39.2		325	35.8	370	S	4.4	2E	0	1	1	0	0	0	011000	F
27	1997	Gull	16-Jun-97	BLKI	36.2		314	34.4	347	S	3.12	0	0	1	1	0	0	0	011000	F
28	1997	Gull	18-Jun-97	BLKI	40.2		325	35.4	410	BBH	7.51	2E	0	1	0	0	0	0	010000	
29	1997	Gull	18-Jun-97	BLKI	37.5		320	33.5	380	BBH	3.37	E	0	1	1	1	1	1	011111	
30	1997	Gull	18-Jun-97	BLKI	38.9		310	36.8	370	BBH	8.46		0	1	1	1	1	1	011111	
31	1997	Gull	18-Jun-97	BLKI	38.1		318	36	360	BBH	22.25		0	1	0	1	1	1	010111	
32	1997	Duck	23-Jun-97	BLKI	36.4	91.3	310	33.9	385	BB	6.97	E	0	1	1	1	1	1	011111	
33	1997	Duck	23-Jun-97	BLKI						BB	7.19	E								
34	1997	Duck	23-Jun-97	BLKI						BB	6.27									
35	1997	Duck	23-Jun-97	BLKI						BB	6.37									
36	1997	Duck	23-Jun-97	BLKI	35.4	89.8	309	33.9	none				0	1	1	1	1	1	011111	
37	1997	Duck	23-Jun-97	BLKI	36.5	89.1	335	34.3	455				0	1	1	0	0	0	011000	
38	1997	Duck	23-Jun-97	BLKI	38.6	94.5	326	36.8	450				0	1	1	0	1	1	011011	M
39	1997	Duck	23-Jun-97	BLKI	39.9	95.7	319	37.1	435				0	1	1	1	1	1	011111	
40	1997	Duck	23-Jun-97	BLKI	38.1	94.7	342	36.5	420				0	1	1	1	1	0	011110	
41	1997	Duck	23-Jun-97	BLKI	39.8	98.3	328	36.8	420				0	1	1	0	0	0	011000	
42	1997	Duck	23-Jun-97	BLKI	40	93.7	329	35.5	415				0	1	1	0	1	0	011010	
43	1997	Duck	23-Jun-97	BLKI	39.9	98.9	326	37.8	405				0	1	1	1	1	0	011110	
44	1997	Duck	23-Jun-97	BLKI	36.8	90.2	317	34.3	405				0	1	1	0	1	0	011010	F
45	1997	Duck	23-Jun-97	BLKI	38.5	94.1	320	34.1	405				0	1	0	1	1	1	010111	

	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1	Notes	L-Top	L-Mddl	L-Bttm	L-AVISE#	R-Top	R-Mddl	R-Bttm	R-AVISE#	Capture Location		
2		RM			79426940	R	G					
3		RE			79426933	R	M					
4		MR			79426943	Y	R					
5		MR			79426945	B	R					
6		MR			79426905	R	B					
7		MR			79426942	R	O					
8		MR			79426944	R	W					
9		MR			79426946	E	R					
10		R				R	Y					
11												
12	1834,4.27											
13												
14												
15												
16												
17												
18	METAL BAND ON RIGHT				79434301							
19	METAL BAND ON RIGHT				79434302							
20	METAL BAND ON RIGHT				79434303							
21	METAL BAND ON RIGHT				79434304							
22		B			79434309	R	R	W				
23		B			79434305	R	R	R				
24	Bird found dead in Glacier Bay around mid August 2000.	B			79434308	Y	R	R				
25		B			79434310	R	W	R				
26		B			79434307	R	R	Y				
27		B			79434306	R	Y	R				
28	Adult cort implant	B			79434312	R	R	G				
29	Adult cort implant	B			79434311	W	R	R				
30	Adult cort implant	B			79434314	G	R	R				
31	Adult cort implant	B			79434313	R	G	R				
32		O			79434318	Y	R	R				
33												
34												
35												
36		O			79434361	E	W	E				
37		O			79434315	R	R	R				
38		O			79434341	W	R	E				
39		O			79434343	R	E	E				
40		O			79434362	W	W	E				
41		O			79434332	Y	B	E				
42		O			79434329	R	B	E				
43		O			79434331	W	B	E				
44		O			79434333	E	R	E				
45		O			79434320	O	E	R				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
46	1997	Duck	23-Jun-97	BLKI	38.7	93	312	35.6	400				0	1	1	0	1	0	011010	
47	1997	Duck	23-Jun-97	BLKI	37.3	94	314	35.5	390				0	1	1	1	1	1	011111	
48	1997	Duck	23-Jun-97	BLKI	37.1	89.6	313	35.6	385				0	1	1	1	1	1	011111	
49	1997	Duck	23-Jun-97	BLKI	38.9	94.2	312	36.4	380				0	1	1	1	1	1	011111	
50	1997	Duck	23-Jun-97	BLKI	37.9	93.7	322	35.1	367				0	1	1	1	1	0	011110	
51	1997	Duck	23-Jun-97	BLKI	35.6	91.2	308	35	360				0	1	1	1	1	0	011110	
52	1997	Duck	23-Jun-97	BLKI	38.8	92.5	305	34	350				0	1	1	1	1	1	011111	
53	1997	Duck	23-Jun-97	BLKI	34.7	87.7	318	32.8	335				0	1	1	1	1	0	011110	
54	1997	Duck	23-Jun-97	BLKI	40.4	95.2	326	36.7	335				0	1	1	0	1	0	011010	M
55	1997	Duck	23-Jun-97	BLKI	41.8	96.6	325	34.8	320				0	1	0	0	0	0	010000	
56	1997	Duck	23-Jun-97	BLKI	37.9	91.8	315	33.8	299				0	1	1	1	1	1	011111	
57	1997	Chisik	24-Jun-97	BLKI	35.4	94	324	35.5	435				0	1	1	1	1	1	011111	
58	1997	Chisik	24-Jun-97	BLKI	38.7	94.3	316	36.1	419				0	1	1	0	0	0	011000	
59	1997	Chisik	24-Jun-97	BLKI	38.8	96.7	328	36.5	415				0	1	1	1	1	0	011110	
60	1997	Chisik	24-Jun-97	BLKI	37.9	90.7	317	32.6	410				0	1	1	1	0	0	011100	
61	1997	Chisik	24-Jun-97	BLKI	38	93.7	320	35.4	410				0	1	0	1	1	1	010111	
62	1997	Chisik	24-Jun-97	BLKI	39.5	97.9	321	36.6	399				0	1	1	1	1	1	011111	
63	1997	Chisik	24-Jun-97	BLKI	37.6	93.2	328	33.6	395				0	1	1	1	1	0	011110	
64	1997	Chisik	24-Jun-97	BLKI	37.7	91.8	313	35	380				0	1	1	1	1	1	011111	
65	1997	Chisik	24-Jun-97	BLKI	35.7	90.4	317	35.3	380				0	1	1	1	1	1	011111	
66	1997	Chisik	24-Jun-97	BLKI	35.8	91.3	326	33.6	380				0	1	0	1	0	0	010100	
67	1997	Chisik	24-Jun-97	BLKI	37.1	89.4	325	33.5	375				0	1	1	1	1	1	011111	
68	1997	Chisik	24-Jun-97	BLKI	37.9	91.7	318	33.5	375				0	1	1	1	1	1	011111	
69	1997	Chisik	24-Jun-97	BLKI	36.2	87.9	320	34.4	370				0	1	1	1	1	1	011111	
70	1997	Chisik	24-Jun-97	BLKI	34.4	88.1	321	33.8	365				0	1	1	0	1	0	011010	
71	1997	Chisik	24-Jun-97	BLKI	37.6	89.4	326	35	365				0	1	1	0	0	1	011001	
72	1997	Chisik	24-Jun-97	BLKI	35.4	89.1	318	34.1	360				0	1	0	1	1	1	010111	
73	1997	Duck	24-Jun-97	BLKI	38.2	95.3	325	35.8	450	BB	57.01	E	0	1	0	1	1	0	010110	
74	1997	Duck	24-Jun-97	BLKI	39	91.4	308	34.7	400	BB	7.42	E	0	1	0	1	1	1	010111	
75	1997	Duck	24-Jun-97	BLKI	37.4	92.2	330	33.6	390	BB	8.7	E	0	1	1	1	1	0	011110	
76	1997	Duck	24-Jun-97	BLKI	36	90.5	305	36.2	390	BB	7.95	E	0	1	0	1	1	1	010111	
77	1997	Duck	24-Jun-97	BLKI	36.5	92.7	320	33.5	380	BB	4.09	E	0	1	1	1	1	1	011111	
78	1997	Duck	24-Jun-97	BLKI	37.7	93	325	34.6	320	BB	11.03	E	0	1	0	0	0	1	010001	
79	1997	Duck	24-Jun-97	BLKI	39.2	93.1	331	33.7	none				0	1	1	1	0	1	011101	
80	1997	Duck	24-Jun-97	BLKI	37.2	95.7	323	37.5	525				0	1	1	1	1	1	011111	
81	1997	Duck	24-Jun-97	BLKI	37.8	93.3	322	35.7	525				0	1	1	1	1	0	011110	
82	1997	Duck	24-Jun-97	BLKI	41.1	100.1	324	36.7	477				0	1	1	1	1	1	011111	
83	1997	Duck	24-Jun-97	BLKI	39.4	98.2	327	37.4	465				0	1	0	1	1	1	010111	
84	1997	Duck	24-Jun-97	BLKI	40.4	99.3	327	36.3	425				0	1	0	1	1	0	010110	
85	1997	Duck	24-Jun-97	BLKI	37.8	94.2	316	34.8	410				0	1	0	1	1	0	010110	
86	1997	Duck	24-Jun-97	BLKI	36.8	93.9	309	34.1	400				0	1	1	1	1	1	011111	
87	1997	Duck	24-Jun-97	BLKI	38.1	91.7	320	35.6	400				0	1	1	1	1	1	011111	
88	1997	Duck	24-Jun-97	BLKI	38.4	90.1	310	35.2	400				0	1	1	1	1	0	011110	
89	1997	Duck	24-Jun-97	BLKI	35.9	92.4	314	34.8	400				0	1	0	1	1	1	010111	
90	1997	Duck	24-Jun-97	BLKI	35.6	90.9	318	36	395				0	1	1	1	1	1	011111	

	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF
46		O			79434317	W	R	R				
47		O			79434321	R	E	R				
48		O			79434328	R	R	E				
49		O			79434344	E	E	E				
50		O			79434364	R	Y	E				
51		O			79434330	E	B	E				
52		O			79434322	W	E	E				
53		O			79434342	Y	R	E				
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72		[illegible]			[illegible]	[illegible]	[illegible]	[illegible]				
73		O			79434339	W	W	Y				
74		O			79434337	R	Y	Y				
75		O			79434340	Y	W	Y				
76		O			79434336	W	Y	Y				
77	Duplicate color combo with a different Duck bird	O			79434335	Y	Y	Y				
78		O			79434338	E	Y	Y				
79		O			79434365	Y	E	W				
80		O			79434357	R	W	R				
81		O			79434356	Y	E	R				
82		O			79434354	E	E	R				
83		O			79434346	E	E	Y				
84		O			79434348	Y	E	Y				
85		O			79434347	W	E	Y				
86		O			79434352	E	Y	E				
87		O			79434350	O	W	Y				
88	YRW/OM, Where's resighting history for 2001	O			79434360	Y	W	R				
89		O			79434355	W	E	R				
90		O			79434349	R	W	Y				

END OF DRAFT APPENDIX

FINAL APPENDIX WILL CONTAIN ALL DATA, ANOTHER 60 PAGES